

Road Construction using Plastic Waste-A Novel Approach

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Abstract: Disposable waste is a serious concern in INDIA. New technologies have been developed to minimize their adverse effects on the environments; generally it is disposed by way of land filling or incineration of materials which are hazardous. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics, by using them in road laying. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the life as well as will help to improve the environment.

Keywords: road construction, plastic waste

1. Introduction

- Disposal plastic waste is a serious problem in India: Increase in population, urbanization and life-style changes were leading to increase in plastic waste. As per industry estimates, the per capita consumption of plastic in India was at about 8 kg during 2011-12 and is expected to increase to around 12 kg by 2017," he said. According to the Central Pollution Control Board of India, around 15,342 ton of plastic waste is generated in the country every day. Proper waste management techniques and recycling of plastics has many advantages such as conservation of non-renewable fossil fuels and reduced consumption of energy among others.
- Disadvantages of toxic chemicals: The waste can contains chemicals, heavy metals, radiations, dangerous pathogens or others toxins. Even households generates hazardous waste from items such as batteries, used computers equipments, and left over paints or pesticides not all hazardous substances are considered toxic. The waste can harm human, animals and plants if they are encounters these toxins buried in the grounds. In the streams runoff, in

groundwater that's supplies drinking waters or in floods water as happened after hurricane, Katrina, toxins, such as mercury, persists in the environments and accumulates.

- Plastics in its molten state is a safe method of disposal by using them in road laying: Industrialized nations are grappling with the problems of expeditious and safe waste disposal. non biodegradable and toxics waste like radioactive remnants can potentially cause irreparable damage to the environments and human health if not strategically disposed. plastics waste fail to reach landfill. it is the improper way of disposing plastics and is defined as the cause of manifold ecological problems. incinerations of plastics waste also significantly reduce the volume of the waste requiring disposal. Natural materials are exhaustible in nature, so alternative materials (plastic) can be used for highway construction and reduces disposal problems and pollution level.
- The construction industry uses plastics for wide range of application because of its versatility, strength to weight ratio and so on some of main types plastics that are used in construction include Acrylic, composites. Polyethylene terephthalate is most widely produced plastics in the worlds. It is used predominantly as a fiber and for blotting or packaging.

2. Materials and methods

A. Segregation

Plastic waste collected from various sources is separated from other wastes. Waste segregation is included in law because it is much easier to recycle. Effectives segregation of wastes means that less waste goes to landfill which makes it cheaper and better for people and the environment, it is also important to segregate for public health.

- *Recycled waste*:-plastic, paper, glass, metals
- *Toxic waste*:- old medicine, paints, chemicals, bulbs, spray canes, fertilizer.
- *Soiled waste*:- Hospital waste such as cloths soiled

with blood and other body fluids.

Proper segregation of waste thus leads to a circular economy creating greens jobs, reducing consumptions of virgin resources and promoting investments and innovations.

B. Cleaning process

Plastic waste is cleaned and dried. The procedure for cleaning solutions should be prepared immediately before uses, work surface should be cleaned with natural detergent and warm water solutions, rinsed and dried before and after each sessions or when visibly soiled. They should also be changed of blood or body substance spills, these items should be washed in detergent and warm water.



Fig. 1. Cleaning process

C. Shredding process

A plastics shredder is machine used to cut plastics into small pieces for granulations, unlike plastics granulators, shredders are designed specifically for larger plastics waste, like car bumpers, pipes, drums and others items too big for granulators, in the process large plastics items are fed into the shredder. It is useful machine for the volume reductions of bulky waste such as reams of paper, paper materials, tires the shredding of different materials such as scrap irons, aluminum, copper, plastics, and industrial waste. All paper items can be shredding but containment in the paper can cause of shredding to increase, glue bindings, three ring binders, computer paper binders, carbon papers.

D. Collection process

The plastic waste retaining on 2.36 mm sieve is collected. All plastics can be disposed in landfill, PVC and halogenated additives are mixed into plastics waste and their incinerations leads to release of dioxins and polychlorinated biphenyls into environment. Waste collections scheme are an essential first step in any waste management process and play a key role in its all over performance. There are many household waste collection scheme in Europe, some capture plastics together with materials, these scheme should share the same objectives of maximizing recovery of recycled and recovering valuable from waste. They should also be aligned with downstream infrastructure for pre-treating.

E. Heating

Bitumen was heated up to the temperature about 160°C-

170°C, which is its melting temp.

F. Mixing

Plastic pieces were added slowly to the hot bitumen of temperature around 160-170°C. The mixture waste manually kept constant about 160-170°C for about 20-30 minutes. In that time period temperature was kept constant at 160-170°C.

G. Testing

Polymer-bitumen mixtures of different compositions were prepared and used for carrying out qualitative tests Penetration test, Ductility test, Flash point test & Fire point test, Stripping test, Ring and ball test and Marshall Stability value test etc.

H. Laying of bituminous blend mix

The plastics waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The road laying temperature is between 110 -120 °C. The bituminous mix design aims to determine the proportion of bitumen, filler, fine aggregate and coarse aggregates to produce a mix which is workable, strong, durable and economical. Bitumen emulsion is mixture of water and bitumen, bitumen is a oil products and it cannot be mixed with water. Addition of emulsifier with water facilitates breaking of bitumen into minute particles and keep it's dispersed in suspension.



Fig. 2. Laying of bituminous blend mix

I. Requirements for 1000M x 3.75M (25mm) road

- 11.250 tons (60/70 grade) bitumen needed
- Shredded Plastics Required: 10% by weight (passing 4.74mm sieve & retaining 2.36 mm).
- Bitumen replaced (saved) by 10% Plastics : 1.125 tons
- Actual Bitumen Required : 10.125 tons
- Aggregate (11.2mm) : 70.875 m³
- Aggregate (6.7mm) : 43.125 m³
- Aggregate Dust : 23.625 m³

Catalytic converter is convert toxic gas to less toxic pollutants which is then collected in a water chamber and is allowed to prepare different chemical for future uses.

J. Separation techniques for heavy metal

When metal tainted water is fed into a tank and an acid or base is added to change the water pH value, this causes the water molecules to separate from heavy metal precipitate, which settles to the bottom of the tank. The clean water is then

siphoned off, more tainted water is introduced. Separation of heavy metal may be done by sulphide precipitation, in order to make the metal sulphide more valuable for reuse, they should be as pure as possible .to separate the metals from each other during the precipitations process different parameters as ph sulphide concentration and redox potential may be controlled, adjustments of the redox potential to specific values results in separation of copper from cadmium even at the same P^H.

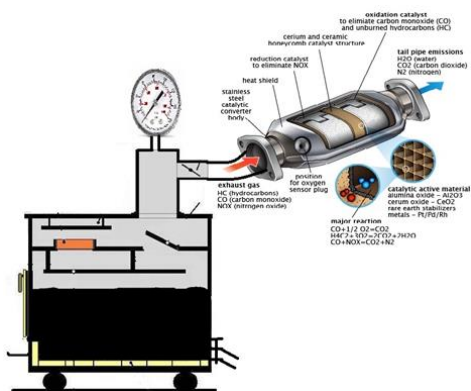


Fig. 3. Mixer fixed with catalytic converter

K. Remove volatile organic compound with membrane techniques

Membrane separation ,a new technology for removing VOCs including evaporation , vapor permeation , membrane contactor and these specials techniques are an efficient and energy saving technology. Vapor permeation can be applied to recovery of organic solvents from exhaust streams, membrane contactor could be used for removing or recovering VOCs from air or waste.

L. Reduction and separation of nitrate & nitrite by liquid membrane encapsulated enzyme

Purified enzyme encapsulated in liquid surfactant membrane have been shown to retain their catalytic activity. In general, previous work on encapsulated has been confined to single enzyme. The system has now been extended to encapsulate a bacterial cell free homogenate. Liquid membrane encapsulated bacterial cell free homogenate reduces effectively NO₃ to NO₂ and other nitrogen compound of lower oxidation state. This technique of removing nitrates and nitrites may have application in waste water treatment. Also it has been shown that encapsulated cell free homogenate does not leak and there is no absorption of the substrate onto the liquid surfactant membrane.

Following test to be performed on Bitumen:

- Penetration value test
- Ductility test

- Flash & fire point test
- Softening point test

M. Preparation of sample

Six Marshall stability will be prepared out of which three will be with the plastics of varying percentage (5%, 10% & 15%) and three sample without plastics waste.

N. Performing Marshall stability test

Marshall stability test will be performed on all of the sample prepared.

Advantage of plastics road:-

- Shelf of road is improved.
- For a stretch of 1KM by 4M road approximately 1 tone bitumen is saved and 1 tone of plastics is reused.
- Load withstanding properly of the road is improved and caters to the increasing road transport.
- Higher resistance to rain and water logging.

O. Disadvantage of plastics road

- Toxics presents in the co- mingled plastics waste would start leaching.
- During the road laying process the presence of the chlorine will be definitely release noxious HCL gas.

3. Conclusion

Plastic roads would be boon for India's hot and extremely humid climate where durable and eco-friendly roads which will relieve the Earth from plastic waste. From all the experiments performed we can conclude that the addition of plastic waste enhances the various properties of an ordinary bituminous road. Considering these factors we can assure that we can obtain a more stable and durable mix for the pavements by polymer modifications. This small investigation not only utilizes beneficially, the waste non-degradable plastics but also provides us an improved pavement with better strength and longer life period. This study will have a positive impact on the environment as it will reduce the volume of plastic waste to be disposed of by incineration and land filling. It will not only add value to plastic waste but will develop a technology, which is eco-friendly.

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